Estimation of Human Risk using the ISC3 Model

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Overview

- Goal:
  - To determine the potential human risk from chemical emissions to air in a systematic, **site-specific** fashion
- A variety of models are used
  - air dispersion, multimedia, exposure, and risk
- A variety of site-specific data is used
  - meteorological, elevation, population, land use, toxicity, and emission
- Model can be used to estimate risk from low level long term exposure from releases from chemical plants or from high exposure due to an accident or terrorist activity
- The software may be used by many offices in the EPA (i.e. NHSRC, OECA, or OPPT) to perform human risk assessments depending on specific needs.

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Air Dispersion Calculations

- The ISC3 (**Industrial Source Complex**) air dispersion model is used to calculate the air concentration distribution of a pollutant surrounding a release source
- The air concentration distribution can be used to determine the area of concern (the area above a certain cutoff concentration)
  - Cutoff concentration can be set at the IRIS RfC
- The ISC3 model can provide several intermediate results
  - The radius of concern (the maximum radius that is above the cutoff concentration)
  - The total population that is exposed to a concentration greater than the cutoff concentration
  - The total population within the area of concern

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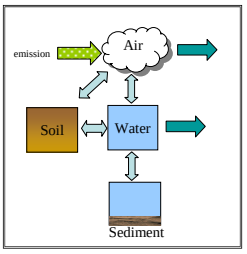
Multimedia Model Calculations

- A **Fugacity model** (Mackay et al., 1992) was used to estimate the pollutant concentration in the air, water, soil, and sediment.
  - Level III model is a steady state, non-equilibrium model that includes degradation, advection, and intermedia transfer.
- The dimensions for the multimedia compartments are determined from the results of the air dispersion calculations



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Exposure Model Calculations

- Exposure to the pollutant from a variety of pathways is estimated
- Pathways used:
  - Inhalation of air
  - Ingestion of water, produce, meat, milk, eggs, fish and soil
- Existence of individual pathways can be determined from land use data
  - Example: if the land use code for row crops appeared in the affected area, exposure from produce would be a possible concern
- Model accounts for the fraction of the food sources that are obtained locally

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Risk Model Calculations

- Risk is determined from the dose rates (from the exposure model) and the chemical's toxicity values
- The risk of lifetime harm from cancer and non-cancer effects can be determined

$$HTP(cancer) = I_{Ingestion} \times SF_{ingestion} + I_{inhalation} \times SF_{inhalation}$$

$$HTP(noncancer) = \frac{I_{Ingestion}}{RfD} + \frac{C_{Air}}{RfC}$$

- The risks can be multiplied by the total affected population to get a more site-specific indication of risk (THTP)

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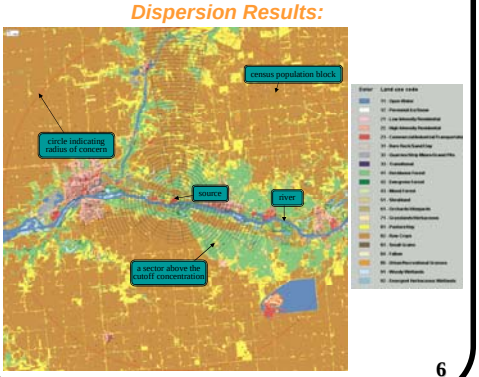
Example Case Study

- GENERAL ELECTRIC CO. (Ottawa, IL) emitted 285,000 lbs of acyrlonitrile (AN) in 1999
- RfC AN=0.002 mg/m^3 (used RfC/10 for C_{cutoff})

Dispersion Results:



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Dispersion Results, cont.

Parameter	Value
Radius of concern	14550 m
Population inside the radius of concern	34625
Population over the cutoff concentration	5592

- A significant population is exposed to at least 1/10 the RfC concentration

Multimedia Results

Exposure medium	Concentration
Air	1.14E-04 mg/m^3
Surface Water	1.35E-03 mg/m^3
Ground Water	1.78E-07 mg/m^3
Fish	1.78E-07 mg/kg fish
Soil	1.53E-05 mg/kg soil

- Acrylonitrile partitions primarily to the air compartment

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Exposure Results

Pathway	Dose Rate mg/kg-day
Inhalation	3.25E-05
Ingestion	
Water	1.61E-07
Produce	1.13E-08
Meat	1.33E-12
Milk	8.29E-13
Eggs	2.02E-14
Fish	3.62E-11
Soil	7.67E-14
Total	1.72E-07

- The majority of the exposure comes from the inhalation route

Risk Results

Score	Value
HTP (noncancer)	5.70E-02*
HTP (cancer)	7.84E-06
THTP (noncancer)	318
THTP (cancer)	0.0438

- The HTP is less than one which would indicate that there isn't a significant chance of harm from lifetime exposure

*The exposure from ingestion was not used in the calculation of risk since the RfD was not available

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